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ORIGINAL ARTICLE

Accountability, utilization and providers for diabetes management in Taiwan, 2000–2009: An analysis of the National Health Insurance database

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KEYWORDS
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Background/Purpose: The prevalence of diabetes has increased worldwide. To obtain nationwide data on accountability and utilization of health resources among diabetes patients in Taiwan, an analysis of the claims data for the National Health Insurance (NHI) from 2000 to 2009 was conducted.

Methods: One-third of the NHI claims database was randomly sampled from 2000 to 2009. Diabetes was defined by three or more outpatient visits with diagnostic codes [International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM): 250 or A code: A181] within 1 year, or one inpatient discharge diagnosis. Accountability items and NHI codes of various metabolic parameters and examinations were identified. Medical utilization was measured by the frequency and cost of care associated with ambulatory visits, hospitalizations, and emergency care within each year.

Results: The annual check-up frequency for various examinations significantly increased from 2000 to 2009. Both the average outpatient department (OPD) cost per diabetes patient/year and the average inpatient department (IPD) cost per time increased 1.34-fold in the past decade. The average OPD cost per diabetes patient and average IPD cost of each admission for diabetes patients was four times and 1.4 times compare with the general population, respectively. The annual average medical cost of each diabetes patient affected with both micro- and macrovascular complications was four times compared with those without vascular complications. There was an increasing trend for diabetes patients to visit

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regional hospital for OPD and IPD, whereas visits to the local hospital decreased in the past decade.

Conclusion: Due to the increased frequency of annual check-ups after various examinations, the quality of diabetes management has improved in the past decade in Taiwan. As diabetes patients affected with both micro- and macrovascular complications incurred costs four times compared with those without complications, it is worth screening high-risk individuals to ensure earlier intervention and thus reduce diabetic complications and healthcare expenditure.

Introduction

Diabetes mellitus (DM) has become a pandemic disorder and this alarming increase in prevalence and the subsequent economic impact are both causes for significant concern. It is estimated that more than 366 million people worldwide suffer from diabetes, and this figure is expected to increase to over 552 million by 2030.[1,2] Type 2 diabetes is also a big challenge to Asian societies, including Taiwan.[3] In a recent analysis of Taiwan's National Health Insurance claims database, researchers found a universal increase in the prevalence of type 2 diabetes for both men and women, with the highest growth among those aged <40 years and >80 years from 1999 to 2004.[4] Furthermore, according to the nationwide survey of accredited Diabetes Health Promotion Centers in Taiwan in 2006, the percentage of DM patients who reached the American Diabetes Association (ADA) goals, that is glycosylated hemoglobin (A1C) <7% (A), blood pressure <130/80 mmHg (B), total cholesterol (TCH) <160 mg/dL, or low-density lipoprotein cholesterol level (LDLc) <100 mg/dL (C), were 32.4%, 30.9%, and 35.3%, respectively. Overall, the percentage of examined diabetes patients who fulfilled current recommended ABC goals was only 4.1%.[5]

Studies have shown that diabetes complications can be slowed or prevented by better management on the part of health care teams and patients.[6,7] To improve the quality of diabetic care, Taiwan has established practice guidelines for diabetic care, implemented accreditation for Diabetes Health Promotion Institutions, and set up shared care networks in 25 counties.[8] Professional accountability, represented by adequacy of laboratory monitoring for diabetic patients, is widely accepted as an indicator of quality assessment for diabetes care in the process domain.[9–11] Moreover, with the increasing prevalence of diabetes and accessibility of heath care resources at different levels of health care providers in Taiwan, the utilization of health resources in the treatment of diabetes and its related complications has increased in past decade.[12]

Only a few studies have reported the professional accountability of diabetes care in Taiwan,[13–16] and only one has analyzed claims data from the NHI program in 2001,[16] therefore, in this study, we used the Taiwan NHI Database for the source population during 2000–2009 to study the trend of accountability, utilization of health care resources, and the distribution of different health care providers for diabetes care in Taiwan during 2000–2009.

Methods

Data source

A universal compulsory NHI program was launched by the Taiwanese government in March 1995. It provided coverage for 95% of the population in 2000, 98% of the population in 2005, and 99.6% of the total population of 23 million in Taiwan in 2009. Although non-Chinese residents are also eligible for this program, they only account for 1% of total beneficiaries. Large computerized administrative and claims data sets derived from this program have been maintained on an ongoing basis by the National Health Research Institute (NHRI) of Taiwan; these are made available to investigators for research purposes after individual health information has been de-identified. In this study, inpatient and outpatient claims data sets for 2000–2009 were used.

Case selection

We searched the Taiwan NHI Database for the source population for 2000–2009 to identify any hospitalized event in which diabetes was one of the discharge or outpatient diagnostic codes (The International Classification of Diseases, 9th Revision, Clinical Modification, ICD-9-CM code 250). The code A181 was used before June 2000 for outpatients only. To protect patient privacy, the NHRI only provided data for one-third of the randomly sampled patients who were identified as having experienced a hospitalized event or ambulatory visit for diabetes from 2000 to 2009. Patients were classified as having diabetes and included in the analysis if they had at least one diabetes admission code or ≥3 outpatient codes within 365 calendar days. To avoid accumulation of misdiagnosis, we used the selection method described for each year.

Outcome variable definitions

The outcome variables of chief interest were those related to medical utilization associated with diabetes. The NHRI database contained the following information: ambulatory, emergency and hospitalization care files, including dates of visits, medical care facilities; patients' sex, date of birth; the three to five diagnoses (ICD-9-CM); and the medical expenses for each visit from all medical care institutions under contract to the Bureau of National Health Insurance

Table 1 Annual check-up frequency for various metabolic parameters, electrocardiogram, fundus examination, nerve conduction velocity and ankle-brachial index in Taiwan (2000–2009).

Parameters	Annual frequency	2000 (%)	2001 (%)	2002 (%)	2003 (%)	2004 (%)	2005 (%)	2006 (%)	2007 (%)	2008 (%)	2009 (%)	*p* for trend
TCH	≥1	60.1	60.8	63.0	63.9	67.6	67.7	68.8	73.4	76.4	79.1	<0.001
TG	≥1	59.1	59.8	62.1	62.8	66.5	66.6	67.8	73.0	76.3	79.4	<0.001
LDLc	≥1	22.7	25.3	33.6	39.0	44.7	44.5	47.1	50.1	52.6	55.8	<0.001
HDLc	≥1	12.4	13.9	22.7	30.1	37.3	38.1	41.9	46.5	47.9	54.0	<0.001
LDLc or HDLc	≥1	23.4	26.5	35.3	41.5	48.0	48.7	52.5	58.3	62.6	67.9	<0.001
A1C	1	20.1	20.4	22.0	22.6	22.0	21.9	21.6	19.5	18.6	17.0	0.083
	2	10.3	11.6	13.4	14.7	15.7	16.6	17.7	18.5	18.5	18.9	<0.001
	3	6.1	7.8	9.5	10.7	12.2	13.4	14.9	16.5	17.3	19.0	<0.001
	≥4	5.2	6.6	8.2	9.3	12.9	14.0	16.7	22.2	25.5	29.7	<0.001
Serum creatinine	≥1	62.9	64.6	67.2	68.2	71.4	71.3	72.0	74.2	77.7	82.0	<0.001
SGPT	≥1	56.8	58.2	62.2	64.2	68.5	68.1	68.9	71.1	72.3	75.3	<0.001
Urine routine	≥1	46.9	47.6	50.2	50.4	53.1	52.3	51.6	51.6	51.4	54.1	<0.001
Microalbuminuria	≥1	3.02	4.43	7.66	9.10	11.99	14.06	16.63	20.18	22.48	25.59	<0.001
Any urine	≥1	48.0	49.3	52.5	53.0	56.1	56.2	56.6	58.2	59.4	63.4	<0.001
Electrocardiogram	≥1	36.6	37.1	38.3	37.4	39.2	38.1	37.5	37.9	37.7	38.3	0.225
Fundus examination	≥1	16.0	17.7	21.4	22.8	25.3	26.0	25.5	24.9	25.2	28.2	<0.001
NCV	≥1	3.9	4.2	4.3	4.1	4.5	3.9	3.9	3.8	3.9	3.9	0.125
ABI	≥1	1.1	1.0	1.2	1.2	1.4	2.8	2.7	2.6	2.9	3.5	<0.001

ABI = ankle–brachial index; A1C = glycated hemoglobin; HDLc = high-density lipoprotein cholesterol; LDLc = low-density lipoprotein cholesterol; NCV = nerve conduction velocity; SGPT = serum glutamic pyruvic transaminase; TCH = total cholesterol; TG = triglyceride.

(BHNI) of Taiwan. Medical utilization was measured by the frequency and cost of care associated with ambulatory visits (including treatment with western medicine, traditional Chinese medicine, and dental visits, community care, and home care). We also measured medical utilization including hospitalization and emergency care within each year. Only direct treatment costs (healthcare provider costs) were investigated. All costs were reported in points and under the global budget floating value system in which 1 point equaled 0.8635–0.9930 New Taiwan dollars (NT$) from 2000 to 2009. In 2012, the exchange rate of the NT$ against the US dollar was 30 to 1.

The healthcare provider for diabetes management in this study was measured by the annual number and frequency in different hospital accreditation levels associated with ambulatory visits (including treatment with western medicine and traditional Chinese medicine, and dental visits, community care, and home care) and hospitalizations every year.

Accountability items and NHI codes were listed as follows: (1) 09005: fasting plasma glucose or capillary blood sugar; (2) 09006: A1C; (3) 09001: total cholesterol (TCH); (4) 09004: triglyceride (TG); (5) 09043: high-density lipoprotein cholesterol (HDLc); (6) 09044: low-density lipoprotein cholesterol (LDLc); (7) 09015: serum creatinine; (8) 09026: serum glutamic pyruvic transaminase (SGPT or ALT); (9) 06012/06013: urine protein; (10) 12111/27065: microalbuminuria; (11) 18001: electrocardiogram (ECG); (12) 23501/ 23502/ 23702: eye fundus examination; (13) nerve conduction velocity (NCV): 41145b, 20016b, 20019b; (14) ankle brachial index (ABI): 18008b, 18008c, 18009a, 18009b, 18011a, 18011b.

Microvascular complications were defined as all types of nephropathy and eye disease. Macrovascular complications were defined as all types of cardiovascular disease, stroke and peripheral vascular disease. These complications defined with ICD-9, op and A-code: (1) all types of nephropathy: 250.4, 403, 404, 585, 586, 581.8x, 791.0, 593.9, v42.0, v45.1, v56.0, v56.8, 39.27, 39.42, 39.43, 39.49, 39.50, 39.53, 39.93, 39.94, 39.95 (A350); (2) all types of eye disease: 362.01, 362.02, 362.53, 362.83, 364.42, 379.23, 369.xx, 14.2x-14.5x, 14.7 (A232); (3) all types of cardiovascular disease: 398.91, 402, 404, 410, 411, 412,

Table 2 Annual check-up frequency for different parameter combinations in Taiwan (2000–2009).

Parameters	2000 (%)	2001 (%)	2002 (%)	2003 (%)	2004 (%)	2005 (%)	2006 (%)	2007 (%)	2008 (%)	2009 (%)	*p* for trend
A1C (≥2) + LDLc or HDLc (≥1)	10.9	13.5	19.9	24.6	30.7	32.5	36.8	44.3	48.7	55.3	<0.001
A1C (≥2) + LDLc or HDLc (≥1) + Any Urine (≥1)	7.8	9.7	15.4	19.3	24.4	25.9	28.9	33.8	36.8	42.7	<0.001
A1C (≥2) + LDLc or HDLc (≥1) + Fundus examination (≥1)	3.3	4.5	8.5	11.2	14.3	15.1	15.8	17.0	17.9	21.5	<0.001

A1C = glycosylated hemoglobin; HDLc = high-density lipoprotein cholesterol; LDLc = low-density lipoprotein cholesterol.

Table 3 DM medical benefit claims from outpatient service in Taiwan (2000—2009).

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	*p* for trend
DM patient number (10,000)	70.7	74.8	81.3	86.8	94.5	100.0	105.5	112.8	120.5	122.3	
DM patients with OPD record (10,000 persons)											
Total	70.5	74.6	81.1	86.5	94.1	99.6	105.2	112.5	120.1	121.9	
Non-dialysis	69.5	73.5	79.8	85.0	92.4	97.7	103.0	110.0	117.3	119.0	
Dialysis	1.0	1.1	1.3	1.5	1.7	1.9	2.2	2.5	2.8	2.9	
Average OPD visit frequency per patient[a]											
Total (FI)[a]	31.8	31.5	31.9	31.7	34.0	34.0	33.3	33.6	33.7	34.4	0.006
	(2.16)	(2.18)	(2.19)	(2.21)	(2.20)	(2.20)	(2.27)	(2.27)	(2.26)	(2.22)	
Non-dialysis (FI)[a]	31.7	31.5	31.8	31.6	33.9	33.8	33.1	33.4	33.4	34.1	0.017
	(2.15)	(2.18)	(2.18)	(2.20)	(2.19)	(2.19)	(2.26)	(2.26)	(2.24)	(2.20)	
Dialysis (FI)[a]	37.3	36.2	37.3	38.6	41.2	41.5	42.3	42.2	43.3	44.7	<0.001
	(2.53)	(2.53)	(2.56)	(2.69)	(2.67)	(2.69)	(2.88)	(2.85)	(2.90)	(2.88)	
OPD cost (billion points)											
Total	27.01	29.24	34.18	38.42	44.96	47.42	50.92	54.93	59.86	62.75	
Non-dialysis	22.83	24.50	28.63	31.68	37.24	38.95	40.59	43.27	46.76	48.76	
Dialysis	4.18	4.74	5.55	6.74	7.72	8.47	10.32	11.65	13.11	13.99	
Average OPD cost per patient[b]											
Total (FI)[b]	38,298	39,206	42,143	44,381	47,744	47,599	48,402	48,823	49,829	51,456	<0.001
	(4.13)	(4.10)	(4.11)	(4.15)	(3.97)	(3.88)	(3.92)	(3.85)	(3.72)	(3.63)	(<0.001)
Non-dialysis (FI)[b]	32,858	33,362	35,888	37,255	40,293	39,859	39,406	39,349	39,851	40,982	0.001
	(3.54)	(3.49)	(3.50)	(3.49)	(3.35)	(3.25)	(3.19)	(3.10)	(2.98)	(2.89)	(<0.001)
Dialysis (FI)[b]	398,651	415,730	415,194	437,392	444,219	444,111	472,528	461,136	466,739	472,127	<0.001
	(42.98)	(43.38)	(40.51)	(40.93)	(36.97)	(36.23)	(38.28)	(36.37)	(34.85)	(33.31)	(<0.001)
OPD drug cost (billion points)											
Total	11.47	12.37	14.52	16.23	19.12	19.35	20.61	21.54	23.27	23.99	
Non-dialysis	11.20	12.08	14.15	15.78	18.60	18.78	19.83	20.59	22.11	22.71	
Dialysis	0.27	0.29	0.37	0.46	0.52	0.57	0.78	0.95	1.16	1.28	
Average drug cost per patient[c]											
Total	16,266	16,590	17,900	18,751	20,305	19,417	19,590	19,149	19,368	19,675	0.007
Non-dialysis	16,123	16,452	17734	18,554	20,120	19,216	19,246	18,722	18,844	19,087	0.020
Dialysis	25,713	25,439	27819	29,585	30,157	29,727	35,813	37,696	41,264	43,314	<0.001

OPD drug cost/OPD cost										
Total (%)	42.5	42.3	42.5	42.3	42.5	40.8	40.5	39.2	38.9	38.2	<0.001
Non-dialysis (%)	49.1	49.3	49.4	49.8	49.9	48.2	48.8	47.6	47.3	46.6	0.004
Dialysis (%)	6.5	6.1	6.7	6.8	6.8	6.7	7.6	8.2	8.8	9.2	<0.001
DM OPD cost/whole population OPD cost											
Total (%)	12.5	12.9	13.9	15.1	15.7	16.1	17.0	17.7	18.3	18.5	<0.001
Non-dialysis (%)	10.6	10.8	11.6	12.5	13.0	13.2	13.6	14.0	14.3	14.4	<0.001
Dialysis (%)	1.9	2.1	2.3	2.6	2.7	2.9	3.4	3.7	4.0	4.1%	<0.001

DM = diabetes mellitus; FI = fold increase compared with whole population in index year; OPD = outpatient service.
[a] Average OPD visit frequency/patient = All DM OPD numbers/DM patients who have OPD record.
[b] Average OPD cost/patient = DM OPD cost/DM patients who have OPD record.
[c] Average OPD drug cost/patient = DM OPD drug cost/DM patients who have OPD record.

413, 414, 428, 36.xx, (A260, A27, A270, A25, A250, A251); (4) all types of stroke: 430, 431, 432, 433, 434, 435, 436, 785.9 (A290—A294); (5) all types of peripheral vascular disease: 440.2x, 443.9, 84.1x, 39.25, 39.29, 39.50, 39.59 (A300, A301, A302).

Statistical analysis

We performed the trend tests to examine linear gradient relationship with the risk of endpoints of interest. All statistical analyses were performed with the SAS version 9.1 (SAS Institute, Cary, NC, USA). A p value <0.05 was considered to be statistically significant.

Results

Annual frequency of checks for various metabolic parameters increases gradually

As shown in Table 1, the annual percentage of diabetes patients undergoing lipid profile checks (including LDLc and HDLc), serum creatinine, SGPT, and any urine analysis (i.e., urine routine or microalbuminuria) increased significantly from 2000 to 2009. The percentage of patients who underwent checks for A1C levels more than twice annually and annual rate for fundus examination also significantly rose from 21.6% and 16.0% in 2000 to 67.6% and 28.2% in 2009, respectively. The annual check-up rate of electrocardiogram remained stable (approximately one-third) over the 10-year period.

Along with improved quality of diabetes management, the annual check-up rate for combinations of A1C, LDLc or HDLc, or any urine analysis, or fundus examination significantly increased from 2000 to 2009 (Table 2).

DM patient utilization of outpatient service from 2000 to 2009

The total number of all diabetes patients visiting OPDs increased from 2000 to 2009. More prominently, the number of dialysis diabetes patients visiting the OPD dramatically increased from 10,000 in 2000 to 29,000 in 2009; this was an increase of 182.5% (Table 3). The average annual OPD visit frequency, OPD cost and drug cost for each diabetes patient also increased significantly from 2000 to 2009. The average annual OPD visit frequency was about 2.2 times as high as that for the whole population. The ratio was much higher for dialysis patients and significantly increased from 2.53 times in 2000 to 2.88 times in 2009. However, the ratio of average annual OPD cost between diabetes patients and the whole population significantly decreased in the past decade. For all diabetes patients and non-dialysis diabetes patients, the percentages of OPD drug cost to total OPD cost decreased significantly from 2000 to 2009. Conversely, for dialysis diabetes patients, the ratio significantly increased by 42.2%. The percentage of DM OPD costs in relation to the whole population OPD cost also significantly increased by 48.0%, 35.8% and 115.8% for all diabetes patients, non-dialysis diabetes patients and dialysis diabetes patients, respectively.

DM patient utilization of inpatient service from 2000 to 2009

As shown in Table 4, the total number of diabetes patients ever hospitalized increased from 2000 to 2009. More prominently, the number of dialysis diabetes patients ever hospitalized dramatically increased from 8900 in 2000 to 22,100 in 2009; a 148.5% increase. The total annual IPD cost and IPD drug cost, average IPD cost and average hospital days for each hospitalization also significantly increased from 2000 to 2009. The percentage of IPD drug costs to total IPD costs significantly decreased by 16.3%, 16.3% and 8.2% from 2000 to 2009 in all diabetes patients, non-dialysis diabetes patients, and dialysis diabetes patients, respectively. The percentage of DM IPD cost to the whole population IPD cost also significantly increased by 36.8%, 29.2% and 95.5% from 2000 to 2009 for all diabetes patients, non-dialysis diabetes patients, and dialysis diabetes patients, respectively.

Etiology of expense in OPD and IPD from 2000 to 2009

We further analyzed OPD and IPD expenditure from 2000 to 2009. The first ranked etiology in terms of expense in OPD comprised endocrine, nutritional and metabolic disease and immune disorders (ICD-9-CM: 240-279) but the percentage decreased significantly from 2000 to 2009. The second ranked etiology in terms of OPD expenditure was diseases of the genitourinary system (ICD-9-CM: 580-629) and this percentage increased significantly from 2000 to 2009. The third highest etiology for OPD expense was diseases of circulatory system (ICD-9-CM: 390-459); this decreased significantly in this study period, which can be attributed to the significantly decreased percentage of hypertension form 2000 to 2009. The percentages for ischemic heart disease and cerebrovascular disease remained consistent in the past decade. In 2000, the top three etiologies in terms of IPD expenditure were diseases of the circulatory system (22.50%), disease of the respiratory system (15.43%) and endocrine, nutritional, metabolic disease and immune disorders (9.32%). However, since 2004, the top three etiologies for IPD expenditure have been diseases of the respiratory system (24.47%), diseases of the circulatory system (20.62%), and neoplasms (8.54%; Table 5). From 2000 to 2009, the percentage of IPD costs dedicated to diseases of the respiratory system and infectious and parasitic diseases significantly increased. By contrast, during the past decade the percentage of IPD costs dedicated to diseases of the circulatory system, diseases of the digestive system, injury and poisoning, and diseases of the genitourinary system as well as endocrine, nutritional and metabolic diseases and immune disorders, and diseases of the musculoskeletal system and connective tissue all decreased significantly (Table 5).

Medical costs for diabetic patients with/without complications

In this study, we further analyzed the medical costs for diabetic patients with or without either microvascular or macrovascular complications. As shown in Table 6, the percentage of diabetes patients without complications remained consistent at ~49% from 2000 to 2009. However, the percentage of diabetes patients with microvascular complications significantly increased by 45.3% from 2000 to 2009. By contrast, the percentage of diabetes patients with macrovascular complications significantly decreased by 13.5% from 2000 to 2009. The percentage of diabetes patients with both macro- and microvascular complications slightly increased from 10.0% in 2000 to 11% in 2009 ($p = 0.121$). The average annual cost also significantly increased by 34.2%, 19.0%, 27.6% and 33.1% from 2000 to 2009 in diabetes patients without any complications, with microvascular complications, with macrovascular complications and with both micro- and macrovascular complications, respectively. The average annual cost for each diabetes patient was about two times higher in diabetes patients with either micro- or macrovascular complications compared with those without any complications. The average annual cost for diabetes patients with both micro- and macrovascular complications was about four times higher compared with those without any complications.

Distribution of inpatient and outpatient services at diabetes health care institutions

As shown in Fig. 1A, about 30% of diabetes patients visited OPD at clinics, and there was an increasing trend towards visiting regional hospitals from 2000 to 2009, with an increase of 18.8%. Conversely, there was a decreasing trend towards visiting medical centers and local hospitals from 2000 to 2009 with a decrease of 12.2% and 21.3%, respectively. As shown in Fig. 1B, about 30% of diabetes patients used the IPD at medical centers. There was an increasing trend towards hospitalization at regional hospitals from 2000 to 2009, with an increase of 25.1%. There was a decreasing trend for hospitalization at local hospitals from 2000 to 2009, with a decrease of 38%.

Discussion

In the present study we used the Taiwan National Health Insurance Database for the source population from 2000 to 2009 to study trends in diabetes care in terms of accountability and utilization of health care resources and providers in the past decade. We found that accountability in terms of measurement of lipid profile, A1C, screening for nephropathy, liver function tests, fundus examinations, and ABI increased significantly in the past decades. Both the annual OPD and IPD costs for diabetes patients also increased significantly in this period. However, the average IPD cost for each period of hospitalization compared with the general population decreased gradually from 1.41 times as high as that in 2005 to 1.37 times as high as that in 2009. The main etiology for OPD expenditure consisted of endocrine, nutritional and metabolic disease and immune disorders, and the chief etiology for IPD expenditure was diseases of the circulatory system in 2000. However, this changed to respiratory disease from 2004 onwards.

Tseng et al analyzed the claims data from the Taipei Branch of the NHI program in 2001 and reported that the

Table 4 DM medical benefit claims from in patient service in Taiwan (2000–2009).

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	*p* for trend
DM patient number (10,000)	70.7	74.8	81.3	86.8	94.5	100.0	105.5	112.8	120.5	122.3	
DM patients with IPD record (10,000)											
Total	20.02	20.84	22.85	22.89	25.63	26.25	26.57	28.09	29.49	30.47	
Non-dialysis	19.13	19.86	21.72	21.64	24.22	24.72	24.93	26.18	27.39	28.26	
Dialysis	0.89	0.97	1.13	1.25	1.41	1.53	1.64	1.91	2.10	2.21	
IPD cost (billion points)											
Total	20.05	21.96	26.06	28.00	34.76	36.88	36.86	39.21	42.07	44.12	
Non-dialysis	17.76	19.46	23.05	24.46	30.27	31.88	31.91	33.09	35.33	36.94	
Dialysis	2.29	2.50	3.01	3.54	4.49	5.00	4.95	6.12	6.74	7.18	
IPD drug cost (billion points)											
Total	3.49	3.58	4.27	4.45	5.60	5.92	5.81	5.91	6.30	6.44	
Non-dialysis	3.18	3.25	3.87	4.00	4.99	5.27	5.17	5.13	5.41	5.53	
Dialysis	0.31	0.33	0.40	0.45	0.61	0.65	0.64	0.78	0.89	0.90	
IPD drug cost/IPD cost											
Total	17.4%	16.3%	16.4%	15.9%	16.1%	16.0%	15.8%	15.1%	15.0%	14.6%	<0.001
Non-dialysis	17.9%	16.7%	16.8%	16.4%	16.5%	16.5%	16.2%	15.5%	15.3%	15.0%	<0.001
Dialysis	13.7%	13.1%	13.2%	12.8%	13.5%	13.0%	12.9%	12.8%	13.2%	12.6%	0.055
Average IPD cost/time											
Total (FI)	52,561	53,902	57,421	62,224	67,091	69,223	69,087	69,481	70,148	70,518	<0.001
	(1.44)	(1.45)	(1.47)	(1.44)	(1.43)	(1.41)	(1.38)	(1.38)	(1.36)	(1.37)	(<0.001)
Non-dialysis (FI)	49,911	51,286	54,703	58,979	63,365	65,226	65,324	64,698	65,294	65,562	<0.001
	(1.37)	(1.38)	(1.40)	(1.36)	(1.35)	(1.33)	(1.30)	(1.29)	(1.29)	(1.27)	(<0.001)
Dialysis (FI)	89,427	89,351	92,721	100,402	111,124	113,595	109,899	115,747	114,881	115,403	<0.001
	(2.45)	(2.40)	(2.37)	(2.32)	(2.37)	(2.31)	(2.20)	(2.30)	(2.23)	(2.24)	(0.001)
Average Hospital days/time											
Total (FI)	10.8	10.9	11.2	11.6	11.9	12.0	11.9	11.8	11.9	11.9	(0.001)
	(1.24)	(1.23)	(1.24)	(1.20)	(1.23)	(1.22)	(1.20)	(1.18)	(1.16)	(1.17)	
Non-dialysis (FI)	10.6	10.7	11.0	11.4	11.6	11.7	11.7	11.5	11.6	11.7	(0.005)
	(1.22)	(1.21)	(1.22)	(1.18)	(1.20)	(1.19)	(1.18)	(1.15)	(1.13)	(1.15)	
Dialysis (FI)	13.7	13.7	13.5	14.2	16.1	14.8	14.2	14.5	14.3	14.2	(0.028)
	(1.57)	(1.55)	(1.49)	(1.47)	(1.66)	(1.50)	(1.43)	(1.45)	(1.39)	(1.40)	
DM IPD Cost/whole population IPD cost											
Total	19.3%	19.9%	21.4%	23.1%	23.5%	24.0%	24.0%	24.8%	25.5%	26.4%	<0.001
Non-dialysis	17.1%	17.6%	18.9%	20.2%	20.5%	20.8%	20.8%	20.9%	21.4%	22.1%	<0.001
Dialysis	2.2%	2.3%	2.5%	2.9%	3.0%	3.2%	3.2%	3.9%	4.1%	4.3%	<0.001

DM = diabetes mellitus; FI = fold increase compared with whole population in index year; IPD = inpatient service.

Table 5 DM medical benefit claims analysis according to classification of diseases in Taiwan (2000—2009).

Classification of diseases (Cost % in OPD)	2000 (%)	2001 (%)	2002 (%)	2003 (%)	2004 (%)	2005 (%)	2006 (%)	2007 (%)	2008 (%)	2009 (%)	*p* for trend
Endocrine, nutritional and metabolic diseases and immunity disorders	26.39	26.22	26.39	26.70	26.77	26.18	25.79	24.96	24.39	24.34	0.008
Diseases of the genitourinary system	17.91	18.89	18.87	19.58	19.12	20.04	20.83	21.92	22.66	23.11	0.001
Diseases of the circulatory system	15.97	16.26	16.72	16.62	16.42	15.82	15.81	15.30	14.89	14.26	0.004
Hypertension	8.27	8.12	7.98	7.72	7.73	7.25	7.02	6.80	6.60	6.30	0.001
Ischemic heart disease	2.37	2.60	2.72	2.86	2.80	2.71	2.84	2.70	2.60	2.50	0.764
Cerebrovascular disease	3.84	4.02	4.47	4.60	4.42	4.39	4.44	4.30	4.20	4.10	0.629
Others	1.48	1.52	1.54	1.44	1.46	1.46	1.52	1.50	1.50	1.40	0.317
Diseases of the digestive system	7.64	7.36	7.06	6.69	6.75	6.48	6.34	6.30	6.12	6.04	0.001
Neoplasms	3.43	6.18	2.66	3.93	4.09	4.60	5.05	5.58	6.00	6.27	0.051
Diseases of the musculoskeletal system and connective tissue	5.45	5.31	5.79	5.63	5.84	5.58	5.50	5.34	5.45	5.46	0.598
Diseases of the nervous system and sense organs	6.19	4.97	5.96	5.53	5.50	5.37	5.21	5.09	5.00	4.96	0.023
Others	17.03	14.82	16.56	15.30	15.51	15.94	15.47	15.51	15.49	15.55	0.291
Cost in IPD											
Diseases of the respiratory system	15.43	17.38	19.63	22.58	24.47	25.26	23.69	24.13	23.49	23.98	0.005
Pneumonia and influenza	5.24	5.69	6.27	6.64	6.71	7.36	6.68	7.26	7.02	7.26	0.001
Respiratory failures and other pulmonary disease	4.53	5.77	8.22	10.97	12.94	13.08	12.53	13.17	12.60	13.17	0.001
Others	5.66	5.91	5.14	4.97	4.82	4.82	4.48	3.70	3.87	3.55	0.001
Diseases of the circulatory system	22.50	22.43	21.28	20.57	20.62	20.15	20.33	20.06	20.29	20.06	0.001
Ischemic heart disease	8.89	9.07	8.76	8.60	8.52	8.28	8.15	8.50	8.50	8.30	0.007
Cerebrovascular disease	7.63	8.02	7.44	6.97	6.48	6.35	6.30	5.70	5.80	5.60	0.001
Others	5.97	5.35	5.09	5.00	5.62	5.52	5.88	5.86	6.00	6.20	0.072
Neoplasms	9.02	9.52	8.91	8.60	8.54	8.76	9.01	9.11	9.26	9.69	0.354
Diseases of the digestive system	9.31	9.51	8.97	8.66	8.24	7.53	7.53	7.80	7.63	7.15	0.001
Injury and poisoning	7.94	7.75	7.27	7.36	6.87	7.10	7.17	6.71	7.04	7.04	0.007
Infectious and parasitic diseases	3.39	3.52	3.54	3.58	4.22	4.76	5.37	5.49	5.47	5.57	0.001
Disease of the genitourinary system	8.13	8.03	7.22	6.72	6.18	5.59	5.55	5.26	5.36	5.19	0.001
Endocrine, nutritional and metabolic diseases and immunity disorders	9.32	8.51	7.73	7.28	6.43	5.99	5.34	5.26	4.80	4.45	0.001
Diseases of the musculoskeletal system and connective tissue	8.13	8.03	7.22	6.72	6.18	5.59	5.55	5.26	5.36	5.19	0.001

IPD = inpatient service; OPD = outpatient service.

percentages of patients who had undergone measurements in that year for plasma glucose, A1C, urinalysis, renal function tests, lipid profile, liver function tests, and fundus examinations were 76.3%, 42.7%, 40.2%, 59.7%, 59.2%, 53.2%, and 16.8%, respectively.[16] These accountability data were similar to our data from 2001. From this, we can infer that the methods and analysis used in our study are reliable. According to the accountability measures of diabetes care reported by BNHI, the percentages of patients who received measurements from 2004 to 2009 for A1C, lipid profile, microalbuminuria and fundus examination were also compatible with our present results.[17] According to Diabetes Quality Improvement Project (DQIP) accountability measures from 1994 to 1999, the baseline and final frequencies for lipid testing, A1C, dilated eye examination, and screening for diabetic nephropathy were as follows: 13—50%, 37—69%, 30—46%, and 37—50%, respectively.[9] Compared with DQIP from 1994 to 1999, the annual rates of fundus examination and microalbuminuria remained too low in Taiwan, even in 2009; thus there is still much room to improve annual check-up rates for fundus examination and microalbuminuria. Diabetic retinopathy is one of the fastest growing causes of blindness and visual impairment in the working-age population.[18] However, most diabetic patients may not experience any warning symptoms during the early stage of retinopathy.[18] Therefore, fundus examination (direct and indirect ophthalmoscopy) is an important screening tool for early detection.

The authors of a recent study analyzing the NHI claims database found a universal increase in the prevalence of type 2 diabetes[4]; therefore, the OPD and IPD medical costs directed towards diabetes patients also saw large increases in the past decade in Taiwan; this was especially true for diabetes patients receiving dialysis, for whom costs increased 234.5% and 213.7% for OPD and IPD, respectively. The average annual OPD and IPD cost for each diabetes patient also significantly increased in the past decade. For OPD patients, these increases were 34.4% for all diabetes

Table 6 Medical costs for DM patients with/without complications in Taiwan, 2000–2009.

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	*p* for trend
DM patient number (10,000)	70.7	74.8	81.3	86.8	94.5	100.0	105.5	112.8	120.5	122.3	
Without complications (10,000) (%)	34.7 (49.1%)	36.6 (49.0%)	39.8 (48.9%)	42.8 (49.3%)	46.4 (49.1%)	48.8 (48.9%)	52.1 (49.4%)	55.9 (49.6%)	60.0 (49.8%)	60.2 (49.2%)	(0.055)
With microvascular complications (10,000) (%)	5.3 (7.5%)	6.1 (8.2%)	7.2 (8.8%)	7.7 (8.9%)	8.7 (9.3%)	9.6 (9.6%)	10.2 (9.7%)	11.1 (9.8%)	12.2 (10.2%)	13.3 (10.9%)	(<0.001)
With macrovascular complications (10,000) (%)	23.6 (33.4%)	24.4 (32.6%)	25.9 (31.8%)	27.3 (31.4%)	29.1 (30.8%)	30.7 (30.7%)	32.0 (30.3%)	33.8 (30%)	35.4 (29.4%)	35.3 (28.9%)	(<0.001)
With macro- and microvascular complications (10,000) (%)	7.1 (10.0%)	7.6 (10.2%)	8.5 (10.5%)	9.0 (10.4%)	10.2 (10.8%)	10.8 (10.8%)	11.2 (10.6%)	12.0 (10.6%)	12.8 (10.6%)	13.4 (11%)	(0.121)
Average annual cost (10,000 points)/patient											
Without complications	3.8	3.8	4.2	4.3	4.8	4.8	4.7	4.7	4.9	5.1	<0.001
With microvascular complications (FI)	8.4 (2.21)	8.6 (2.26)	8.9 (2.12)	9.5 (2.21)	10.1 (2.10)	10.0 (2.08)	10.1 (2.15)	10.0 (2.13)	10.1 (2.06)	10.0 (1.96)	0.001 (0.005)
With macrovascular complications (FI)	7.6 (2.00)	7.7 (2.03)	8.7 (2.07)	8.9 (2.07)	9.8 (2.04)	9.7 (2.02)	9.4 (2.00)	9.3 (1.98)	9.4 (1.92)	9.7 (1.90)	0.005 (0.012)
With macro- and microvascular complications (FI)	16.0 (4.21)	16.2 (4.26)	17.2 (4.10)	18.2 (4.23)	19.7 (4.10)	20.0 (4.17)	20.2 (4.30)	20.8 (4.43)	21.1 (4.31)	21.3 (4.18)	<0.001 (0.301)

DM = diabetes mellitus; FI = fold increase compared with DM patients without complications in index year.

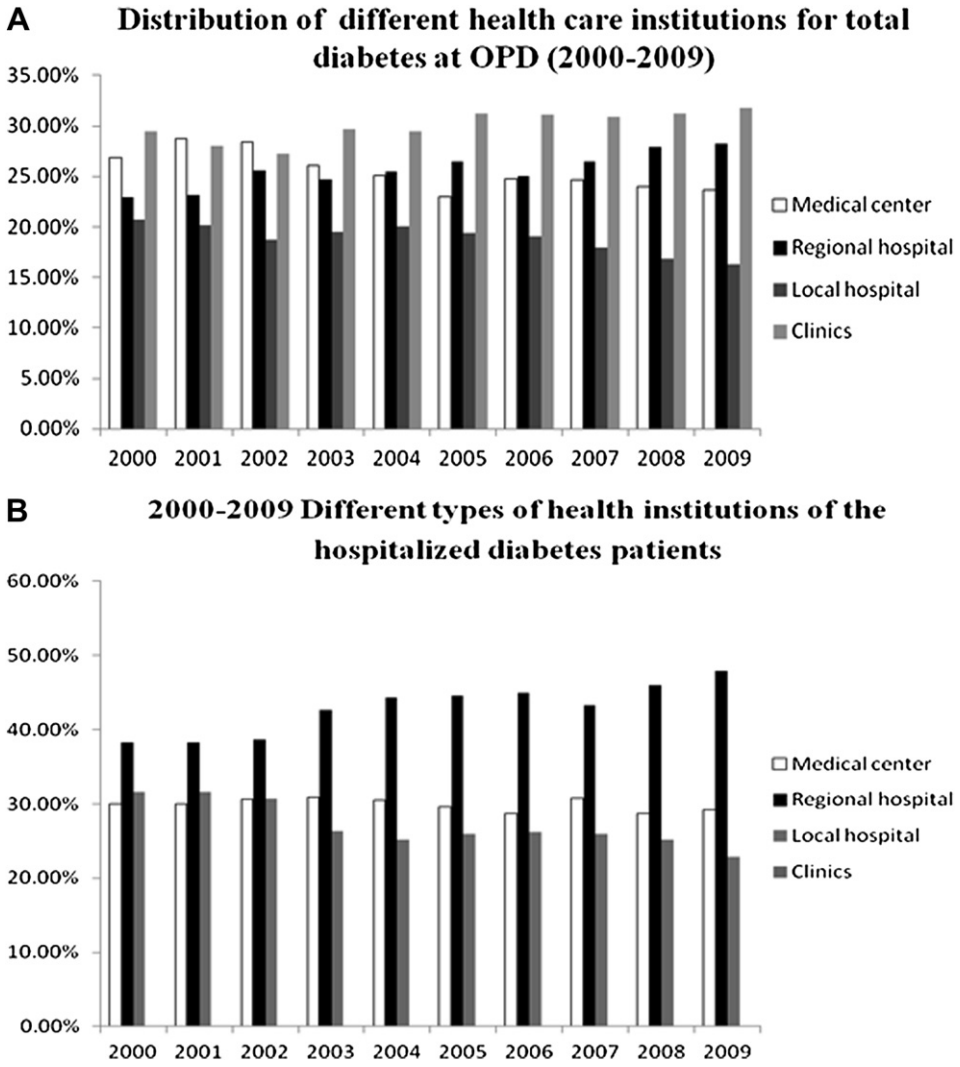

Figure 1 Distribution of different health care institutions for total diabetes patients (2000—2009) at (A) outpatient service and (B) inpatient service.

patients, 24.7% for non-dialysis diabetes patients, and 28.4% for dialysis diabetes patients. For IPD patients, these increases were 34.2%, 34.2%, and 29% for the all diabetes, non-dialysis diabetes, and dialysis diabetes groups, respectively. Compared with the general population, the average annual OPD cost for each diabetes patient was 2.89 and 33.31 times as high as that in 2009 in non-dialysis and dialysis diabetes patients, respectively. The frequency of OPD visits was also much higher in diabetes patients than for the general population, especially among diabetes patients receiving dialysis. In 2009, the rate of visits for non-dialysis patients was 2.20 times as high as that in the general population, and the rate for dialysis patients was 2.88 times as high as that for the general population. One recent study reported that progression of nephropathy was strongly associated with higher subsequent medical care costs in hypertensive patients with diabetes.[19] A Canadian study has reported that population-based screening for chronic kidney disease with assessment of estimated glomerular filtration rate is not cost-effective overall or in subgroups of people with hypertension or older people. However, targeted screening of people with diabetes is associated with a cost per quality-adjusted life years (QALY) that is similar to that accepted in other interventions funded by public healthcare systems, and is within a range that is generally considered acceptable.[20] Therefore, early detection of and intervention for chronic kidney disease in diabetes patients was a critical issue in decreasing the burden on the health care system.

The medical costs of OPD for diabetes care accounted for approximately 12.5% of all OPD expenditure in Taiwan in 2000, and this significantly increased to 18.5% in 2009. Similarly, the medical costs of IPD for diabetes care accounted for approximately 19.3% of total IPD cost in 2000 and significantly increased to 26.4% in 2009. According to the health economic data from the UK, diabetes accounted for approximately 10% of the total health resource expenditure in 2011.[21] The higher prevalence of diabetes in Taiwan (9.59%, age 20—79 years)[1] compared with the UK (6.84%, age 20—79 years)[1] may explain the fact that diabetes care comprises a higher percentage of medical resources expenditure in Taiwan. Therefore, prevention of

diabetes is an important issue in national health policy in Taiwan in terms of reducing both the economic and health burdens. In the present study, we also found that medical costs for diabetes patients with either microvascular or macrovascular complications were approximately twice as high as those for patients who had no complications. Furthermore, for the diabetes patients with both microvascular and macrovascular complications, medical expenses dramatically increased to four times as high as those for diabetes patients without any complications. Therefore, an increase in efforts to improve the quality of diabetes care and decrease the complication rate is mandatory in Taiwan because this will decrease the health economic burden for both individuals and the nation.

As shown in Table 6, the percentage of diabetes patients with microvascular complications alone was lower than in those who have both micro- and macrovascular complications. According to NHI claims data in the present study, about half of diabetes patients with defined microvascular complications (i.e., all types of eye disease and kidney disease) had concomitant defined macrovascular complications (i.e., all types of cardiovascular disease, stroke and peripheral vascular disease). By contrast, only about 27% of diabetes patients with defined macrovascular complications had concomitant defined microvascular complications (data not shown). It may explain why the percentage of diabetes patients with macrovascular complications alone was the highest among all diabetes patients, and the percentage of those who have microvascular complications alone was the lowest among all diabetes patients. The average annual cost for each diabetes patient with microvascular complications alone was slightly higher than in those who had macrovascular complications alone, which maybe explained that the medical expenditure for diabetes patients receiving dialysis (classified as microvascular complications) was about 11 times and 1.7 times as high as those for the non-dialysis diabetes patients at the OPD and IPD, respectively (Tables 3 and 4).

In this study, we found that the average medical cost ratio between diabetes and non-diabetes patients significantly decreased for both non-dialysis and dialysis diabetes patients in the period 2000—2009. These trends may be partially explained by earlier detection of diabetes after nationwide health insurance implementation in 1994. Before this implementation, the undiagnosed rate of diabetes was roughly 50%,[22] but the undiagnosed rate of diabetes has now decreased to around 30% according to claims data from the NHI and the 5th International Diabetes Federation (IDF) atlas.[1]

The top three etiologies in terms of OPD expenditure were endocrine, nutritional and metabolic disease and immune disorders; diseases of the genitourinary system; and diseases of the circulatory system. The percentage of OPD expenditure dedicated to endocrine, nutritional, and metabolic disease and immune disorders; and diseases of the circulatory diseases significantly decreased in the past decade. However, the percentage of OPD expenditure given over to diseases of the genitourinary system significantly increased in that period. In 2000, the top three etiologies for IPD expenditure were diseases of the circulatory system, disease of the respiratory system and endocrine, nutritional, metabolic disease and immune disorders in 2000. Conversely, the top three etiologies of IPD expense shifted to disease of the respiratory system, diseases of the circulatory system, and neoplasms from 2004 onwards (see Table 5). During the past decade, the percentage of IPD costs dedicated to the treatment of diseases of the respiratory system, and infectious and parasitic diseases saw a significant increase. By contrast, significant IPD cost decreases were seen in the past decade for the following: diseases of the circulating system; diseases of the digestive system; injury and poisoning; diseases of the genitourinary system; endocrine, nutritional and metabolic diseases and immune disorders; and diseases of the musculoskeletal system and connective tissue. According to the analysis of Taiwan NHI claims data, the overall incidence of diabetic ketoacidosis also linearly decreased between 1997 and 2005.[23] The change in disease pattern in diabetes patients provided important information for the implementation of health policy in Taiwan.

One Taiwan-based study has highlighted the importance of considering the level of the major care unit and the frequency of visits for each patient for research into the accountability of diabetes care.[16] In this study, we found that diabetes patients were increasingly likely to visit the OPD in regional hospitals, whereas the utilization of medical centers and local hospitals decreased in the past decade. Similarly, there was an increasing trend towards hospitalization at regional hospitals and a decrease in hospitalization in local hospitals. Whether these change influenced the quality of care and outcome of diabetes patients needs further investigation.

In conclusion, the frequency of annual examinations for various metabolic parameters for diabetes patients increased gradually from 2000 to 2009; this indicates an improvement in the quality of diabetes management in Taiwan. However, diabetes mellitus patients with both microvascular and macrovascular complications place a large financial burden on the healthcare system. Therefore, it is worth screening high-risk individuals for earlier intervention to reduce diabetic complications and healthcare expenditure. At the same time, the change of disease pattern in diabetes patients in the past decade provides important information for the implementation of health policy in Taiwan.

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